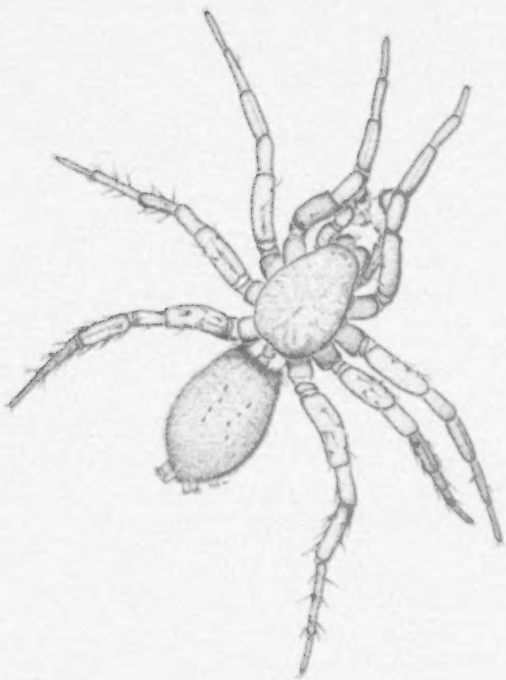
COSEWIC
Assessment and Status Report

on the

Georgia Basin Bog Spider
Gnaphosa snohomish

in Canada



SPECIAL CONCERN
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Production note:
COSEWIC would like to acknowledge Robert Foster and Allan Harris for writing the status report on Georgia Basin Bog Spider (*Gnaphosa snohomish*), in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Dr. Paul Catling, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

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Georgia Basin Bog Spider — Reproduced with permission of Robb Bennett and the Journal of the Entomological Society of Ontario).

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COSEWIC
Assessment Summary

Assessment Summary – November 2012

Common name
Georgia Basin Bog Spider

Scientific name
Gnaphosa snohomish

Status
Special Concern

Reason for designation
This small (1 cm) wetland spider has a very limited global distribution, occurring in the Georgia Basin and western Washington State. In Canada, it is known from only 4 sites in southern British Columbia. These populations may become threatened over a very short time period. The greatest threat is inundation by sea water since three of the four known sites are less than 3 m above sea level and are at risk from projected increases in the frequency and severity of storms.

Occurrence
British Columbia

Status history
Designated Special Concern in November 2012.

COSEWIC
Executive Summary

Georgia Basin Bog Spider
Gnaphosa snohomish

Wildlife Species Description and Significance

Georgia Basin Bog Spider (*Gnaphosa snohomish*) is a member of the ground spider family (Family Gnaphosidae). Ground spiders are 2-clawed spiders with enlarged, cylindrical, separated anterior lateral spinnerets and modified posterior median eyes. *Gnaphosa* spiders are characterized by a serrated keel on the posterior margin of the mouthparts. Georgia Basin Bog Spider is similar to other species in the genus and is distinguished by details of the genitalia. The body is 7.5 to 12 mm long. The abdomen is covered with short hairs. The legs are relatively stout with numerous large hairs. The carapace, abdomen, and legs are light brown to dark chestnut brown. The species is endemic to the Puget Sound and Georgia Basin area and about half of the known occurrences are in Canada.

Distribution

The global distribution of Georgia Basin Bog Spider is restricted to the southern Gulf Islands, Puget Sound and Georgia Basin area of extreme southwestern British Columbia and adjacent Washington. In Canada, it occurs in three bogs and one marsh. Sites on the Gulf Islands (other than Tumbo Island) and adjacent Vancouver Island are believed to be transient and the result of wind dispersal of single individuals.

Habitat

Georgia Basin Bog Spider is primarily associated with bogs throughout its Canadian and US range. With few exceptions the non-bog occurrences of this spider are of single specimens, likely the result of random ballooning events rather than being an indication of established populations. A cattail marsh on the Gulf Islands is the only known Canadian location for an established population associated with a wetland other than a bog. Five of the six sites in Washington State where this species occurs are bogs. Typical bog habitat is open heath with *Sphagnum* moss cover and ericaceous shrubs.

Biology

Most species in the genus are ground-dwelling nocturnal hunters that actively pursue their prey at night and remain under cover during the day. They are generalist predators on a range of prey including insects and other spiders. Georgia Basin Bog Spider overwinters in the subadult stage and matures in early spring. Life span is probably one year. In addition to simple localized wandering, dispersal of young spiders may occur by ballooning, involving climbing to an elevated perch and extruding a silk thread, which is caught in an updraft and carries the spider away. This method of dispersal is random and success for individual Georgia Basin Bog Spiders depends upon landing in suitable habitat. Ballooning by Georgia Basin Bog Spiders is supported by occurrences of single individuals in non-bog habitat in the Gulf Islands and adjacent Vancouver Island 20 to 30 km from known populations.

Population Sizes and Trends

Population size and trends are unknown but the species is likely declining due to continuing deterioration and loss of habitat. Most collections have occurred relatively recently (<25 years) and known populations have not been monitored.

Threats and Limiting Factors

Saltwater flooding resulting from rising sea levels (due to climate change), winter storms, and tsunamis could impact all but one site; this is considered to be the most serious threat. Natural system modification, in particular destruction of wetland habitat and succession of native and exotic invasive plant species, currently or potentially impacts all sites of Georgia Basin Bog Spider. Agricultural impacts such as recent and historical peat extraction, cranberry farm development, and related changes to hydrological processes as well as pollution from agriculture, industry, and garbage disposal are important at two sites at least. Overall threat impact is calculated to be "very high" based on NatureServe's Threat Calculator and seven categories of threat that are relevant.

Protection, Status, and Ranks

COSEWIC assessed the Georgia Basin Bog Spider as Special Concern in November 2012. Currently, Georgia Basin Bog Spider is not protected by any endangered species legislation in Canada or the United States. It has been ranked as globally and nationally imperiled in Canada.

TECHNICAL SUMMARY

Gnaphosa snohomish
Georgia Basin Bog Spider Gnaphose de Snohomish
Range of occurrence in Canada (province/territory/ocean): British Columbia

Demographic Information

Generation time	1 yr
Is there an inferred continuing decline in number of mature individuals?	Yes, based on habitat degradation
Estimated percent of continuing decline in total number of mature individuals within 5 years	Unknown
Suspected percent reduction in total number of mature individuals over the last 10 years.	Unknown
Suspected percent reduction in total number of mature individuals over the next 10 years.	Unknown
Suspected percent reduction in total number of mature individuals over a time period including both the past and the future. *Based on 85% loss of wetland habitat in Lower Mainland between 1827 and 1990 and loss of the single largest known population (Burnaby Marshlands) in late 1990s.*	Unknown
Are the causes of the decline clearly reversible and understood and ceased? *Relatively well understood but neither clearly reversible nor ceased. Degradation of bog habitat by altered hydrology, accelerated vegetation succession, and invasive plant species continues*	No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence *This represents the 4 sites with current or historical well established populations. Including non-viable occurrences it is 1306 km²*	620 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value). *This represents the 4 sites with current or historical well established populations. Including non-viable occurrences it is 28 km²*	16 km²
Is the total population severely fragmented? *Subpopulations are isolated from each other, "ballooning" of young spiders may result in colonization of new habitats but the process is random and almost all ballooning individuals are expected to be unsuccessful.*	Probably

Number of locations *(i) Tumbo Is.: Threatened by vegetation succession, winter storms, sea level rise, and tsunamis. Probably threatened by small population size and isolation from other populations.* *(ii) Burnaby Marshland: Threatened by agricultural and industrial development, vegetation succession, pollution, winter storms, sea level rise, and tsunamis. Probably threatened by isolation from other populations. Largely destroyed in the 1990s.* *(iii) Burns Bog: Threatened by commercial and industrial development (unprotected portion), vegetation succession, pollution, winter storms, sea level rise, and tsunamis. Probably threatened by isolation from other populations.* *(iv) Blaney Lake: Threatened by vegetation succession. Probably threatened by small population size and isolation from other populations* *Tumbo Island, Burnaby Marshland, and Burns Bog are considered to represent one location because of their low elevation and the likelihood of a single saltwater flooding event to impact all three sites.* *Records from Cabbage Is., Portland Is., and Island View Beach are not considered to represent viable populations. Despite intensive sampling only single specimens have been recorded at each site and populations likely do not exist at these locations. The occurrences are likely a result of random wind dispersal.* *Based on an analysis of search effort, very few, if any, additional sites are expected to be discovered.*	2
Is there a projected continuing decline in extent of occurrence?	Yes
Is there a projected continuing decline in index of area of occupancy?	Yes
Is there a projected continuing decline in number of populations?	Yes
Is there a projected continuing decline in number of locations? *Although there are only two locations the high threat level suggests decline at both*	Yes
Is there a projected continuing decline in quality of habitat?	Yes
Are there extreme fluctuations in number of populations? *Most occurrences are recently discovered (<25 years) and have not been monitored.*	Unknown
Are there extreme fluctuations in number of locations*? *Most occurrences are recently discovered (<25 years) and have not been monitored*	Unknown
Are there extreme fluctuations in extent of occurrence? *Most occurrences are recently discovered (<25 years) and have not been monitored*	Unknown
Are there extreme fluctuations in index of area of occupancy? *Most occurrences are recently discovered (<25 years) and have not been monitored*	Unknown

Number of Mature Individuals (in each population)

Population	N Mature Individuals
	Unknown
Total	

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	No analysis has been completed

Threats (actual or imminent, to populations or habitats)

The most significant threat to Georgia Basin Bog Spider is saltwater flooding from tsunamis, climate change, and/or winter storms. Degradation or destruction of its wetland habitat through vegetation succession caused by recent and historical peatland drainage and invasion of native and exotic plant species is the second most serious threat. Other significant threats are pollution from industrial and agricultural sources and garbage disposal, invasive species, agricultural activity, industrial and residential development, and geological events.

Rescue Effect (immigration from outside Canada)

1	Status of outside population(s)? *Unknown. Little or no monitoring has been conducted. Current status of most historical Washington populations is unknown. Threats are presumably similar to those in Canada.*	
	Is immigration known or possible? *Bog and other wetland habitats in Washington State have been extensively sampled and few new sites are likely to be discovered there. Some Washington sites are within 100 km of current or potential habitat in Canada.*	Possible
	Would immigrants be adapted to survive in Canada?	Probably
	Is there sufficient habitat for immigrants in Canada?	Possibly
	Is rescue from outside populations likely?	Possibly

Status History

COSEWIC: Designated Special Concern in November 2012.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	not applicable

Reasons for designation:

This small (1 cm) wetland spider has a very limited global distribution, occurring in the Georgia Basin and western Washington State. In Canada, it is known from only 4 sites in southern British Columbia. These populations may become threatened over a very short time period. The greatest threat is inundation by sea water since three of the four known sites are less than 3 m above sea level and are at risk from projected increases in the frequency and severity of storms.

Applicability of Criteria

Criterion A: Not applicable because population sizes are unknown and declines are not documented.
Criterion B: Not applicable. Comes close to meeting Endangered B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v). EO is 620 km² and IAO is 16 km² (excluding 3 sites with likely non-viable occurrences). There are only 2 locations based on the threat of saltwater inundation (so "a" is applicable). Threat impact is calculated to be very high and declines are projected in EO, IAO, habitat quality, number of locations and number of mature individuals (so "b i,ii,iii,iv and v" are applicable). However, it is considered that there may be additional sites.
Criterion C: Not applicable because population size is unknown and declines are not documented.
riterion D: Not applicable. Comes close to meeting Threatened D2 because only 2 locations and a very restricted area of occupancy and a very high threat impact, but there may be additional locations.
Criterion E: Not applicable – no analyses.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Georgia Basin Bog Spider

Gnaphosa snohomish

in Canada

2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Kingdom	Animalia -- Animal, animals, animaux
Phylum	Arthropoda -- arthropodes, arthropods, Artrópode
Subphylum	Chelicerata -- cheliceriformes, quelicerado, queliceriforme
Class	Arachnida -- arachnids, aracnídeo, araignées
Order	Araneae -- aranha, spiders
Suborder	Opisthothelae: Araneomorphae: Entelegynae
Family	Gnaphosidae Simon
Genus	*Gnaphosa*
Species	*Gnaphosa snohomish* Platnick and Shadab, 1975

Gnaphosa snohomish Platnick and Shadab, 1975, Georgia Basin Bog Spider, belongs to the ground spiders family (Araneae: Gnaphosidae). The species was described in 1975 based on two specimens, the male holotype and a female paratype, from Snohomish County, Washington (Platnick and Shadab 1975). Bennett *et al.* (2006) subsequently revised the description and keys, incorporated new diagnostic characters, and discussed habitat.

Twenty species of the genus *Gnaphosa* occur in the Nearctic region (Bennett *et al.* 2006). Bennett *et al.* (2006) considered Georgia Basin Bog Spider to be a member of the *lucifuga* group (along with *G. antipola* which is found in BC and the northwestern US), a group primarily associated with low elevation sites, especially saline areas and beaches (Platnick and Shadab 1975). Male *G. snohomish* are distinguished from *G. antipola* by the possession of a single large spine on the base of the embolus (the male intromittent organ). Female *G. snohomish* have a smaller epigynal hood (external structure at the reproductive opening).

Morphological Description

Males measure 7.44 to 9.92 mm from the tip of the head to the tip of the abdomen and females measure 7.44 to 11.78 mm (Figure 1). The abdomen is elongate, cylindrical, slightly flattened dorsoventrally and covered with short hairs. The legs are relatively stout with numerous macrosetae. The carapace, abdomen, and legs are light brown to dark chestnut brown. Measurements and detailed descriptions of the genitalia are found in Platnick and Shadab (1975), Platnick and Dondale (1992), and Bennett *et al.* (2006).

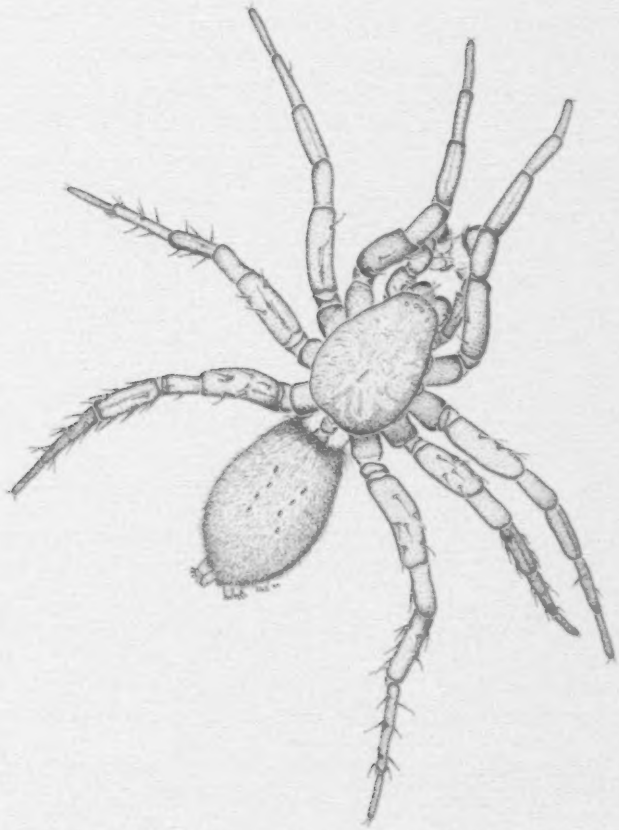

Figure 1. Georgia Basin Bog Spider (male) from Burnaby Marshlands, British Columbia. (Illustration by Robb Bennett. Reproduced with permission of Robb Bennett and the Journal of the Entomological Society of Ontario.)

Population Spatial Structure and Variability

No population structure or genetic studies have been conducted on Georgia Basin Bog Spider in Canada or elsewhere. The species may be able to disperse by ballooning from US sites and between Canadian sites (see **Dispersal and Migration**).

Designatable Units

The Canadian population is represented by a single designatable unit within the Georgian Depression Ecoprovince (Demarchi 2011). The designatable unit is based on morphological considerations; no genetic or behavioural studies have been conducted.

Special Significance

Georgia Basin Bog Spider is endemic to the Puget Sound and Georgia Basin area (Bennett *et al.* 2006), and seven of the fifteen known sites are within Canada (Figure 2). Bogs, which are rare and rapidly declining ecosystems in southern BC (Boyle *et al.* 1997; Hebda *et al.* 2000; BC Conservation Data Centre 2012a,b), are the primary habitat for this spider. Additional species that inhabit similar wetland ecosystems include other imperiled taxa such as the Pacific Water Shrew (*Sorex bendirii*), Dun Skipper (*Euphyes vestris*) (BC Conservation Data Centre 2011), and a rare, bog-associated ground beetle, *Agonum belleri*, (Coleoptera; Carabidae) which has been collected from two Georgia Basin Bog Spider sites (Blaney Bog and Burns Bog).

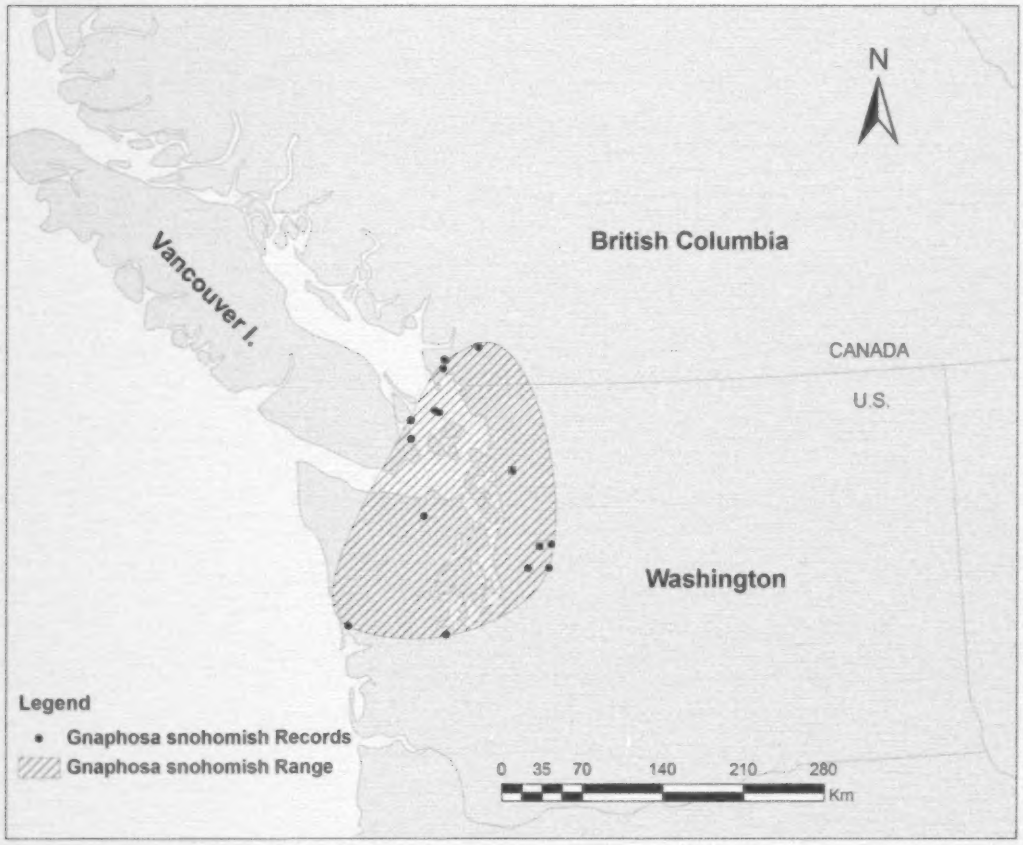

Figure 2. Global range of Georgia Basin Bog Spider. All known records of the species are shown (based on Bennett *et al.* 2006, R. Bennett pers. comm. 2011; J. Bergdahl pers. comm. 2011).

Georgia Basin Bog Spider is not known to have cultural significance to First Nations in the region. However, Burns Bog has cultural, archaeological, traditional, and current use importance to the Tsawaassen, Semiahmoo and Sto:lo First Nations (Hebda *et al.* 2000). Further, bog ecosystems including Burns Bog are known to have many plants of ethnobotanical importance to First Nations people in the region (Howie 2002).

DISTRIBUTION

Global Range

The global distribution of Georgia Basin Bog Spider is restricted to the Gulf Islands, Puget Sound and Georgia Basin area of extreme southwestern BC and adjacent Washington State (Figure 2).

Globally Georgia Basin Bog Spider has been recorded from 15 sites: 7 in Canada (of which 3 are considered to be non-viable occurrences) and 8 in Washington State (Table 1; Figures 2, 3). The global maximum extent of occurrence based on a minimum convex polygon is approximately 26,000 km^2, about 40% of which is water and less than about 5% is suitable bog or wetland habitat (Ward *et al.* 1992). Approximately 10% of the global range and 50% of the known sites for Georgia Basin Bog Spider are in Canada.

Table 1. Sampling effort in or in close proximity to wetland habitats (peatlands and marshes) in southwestern British Columbia 1989 - 2012. Vouchers from all these studies are at Royal British Columbia Museum, the Canadian National Collection, or the American Museum of Natural History.

Site	Effort	Results*	Source
Sites yielding *Gnaphosa snohomish*			
Burnaby Marshlands, Burnaby	Many trap nights in 1998	210 a+ j	Bennett *et al.* 2006
Island View Beach, Victoria	Many trap nights in 2003-2004	1f	R. Bennett pers. comm. 2011
Cabbage Island	Over 4000 trap nights in 1989 and 1990	1 f	R. Bennett pers. comm. 2011, J. Bergdahl pers comm. 2011
Tumbo Island	Over 3000 trap nights over several months in 1989 and 1990	43 m, 72 f, 57 j	R. Bennett pers. comm. 2011, J. Bergdahl pers comm. 2011
Portland Island	Over 1400 trap nights over several months in 1989	1 f	R. Bennett pers. comm. 2011, J. Bergdahl pers comm. 2011
Burns Bog, Richmond	150 trap nights May 26 - 29 2010	4 m, 2 f	Present study
Blaney Lake, Maple Ridge	60 trap nights May 27 - 29 2010	1 m	Present study

Site	Effort	Results*	Source
Sites not yielding *Gnaphosa snohomish*			
Jordan River Bog, San Juan Ridge, Vancouver Island	Hand collecting (~9 hrs) and 5 pitfall traps for three months in 2010	0	R. Bennett pers. comm. 2011
Rithet's Bog, Victoria	5 pitfall traps for three months in 2010	0	R. Bennett pers. comm. 2011
southern Saltspring Island	Hand collecting - ~ 3 hrs in spring 2008	0	R. Bennett pers. comm. 2011
Chickadee Lake, Denman Island	Hand collecting (~3 hrs) and Berlese extraction of moss sample in 2008	0	R. Bennett unpub. data
Colony Farm Regional Park, Port Coquitlam	Effort unknown. 2009	0	R. Bennett pers. comm. 2011, Parkinson *et al.* 2009
Richmond Nature Park, Richmond	60 trap nights May 26 - 29 2010	0	A. Harris pers. comm. 2011
Bowser Bog, near Bowser	Hand collecting (~6 hrs) and Berlese extraction of several litter and moss samples between 2006 and 2012	0	R. Bennett unpub. data
Yellow Point Bog, near Nanaimo	Hand collecting (~6 hrs) and Berlese extraction of several litter and moss samples between 2006 and 2012	0	R. Bennett unpub. data
Brandywine Bog, south of Whistler	Hand collecting (~6 hrs) and Berlese extraction of moss samples 2011	0	R. Bennett unpub. data
19 sites within the municipalities of Delta and Surrey (including sites with or in close proximity to various marshes and other wetlands)	194 pitfall traps for a total of 13406 trap nights	0	Parkinson and Heron 2010
Six sites in the Lower Mainland (including sites with or in close proximity to various marshes and other wetlands)	Substantial but unknown number of pitfall traps and trap nights	0	Parkinson *et al.* 2009

*a = adult, m = male, f = female, j = juvenile

Canadian Range

Georgia Basin Bog Spider occurs in extreme southwestern BC on the Lower Mainland, southeastern Vancouver Island, and the southern Gulf Islands (Table 1, Figure 3). The earliest collection record in Canada is Blaney Lake (1968) although the species was not described until 1975 (Bennett *et al.* 2006). Other Lower Mainland collection records include Fraser River Delta at the Burnaby Marshlands in 1998 (Bennett *et al.* 2006) and Burns Bog and Blaney Lake in 2010 (A. Harris and R. Foster pers. comm. 2011) (Figure 4, Table 1).

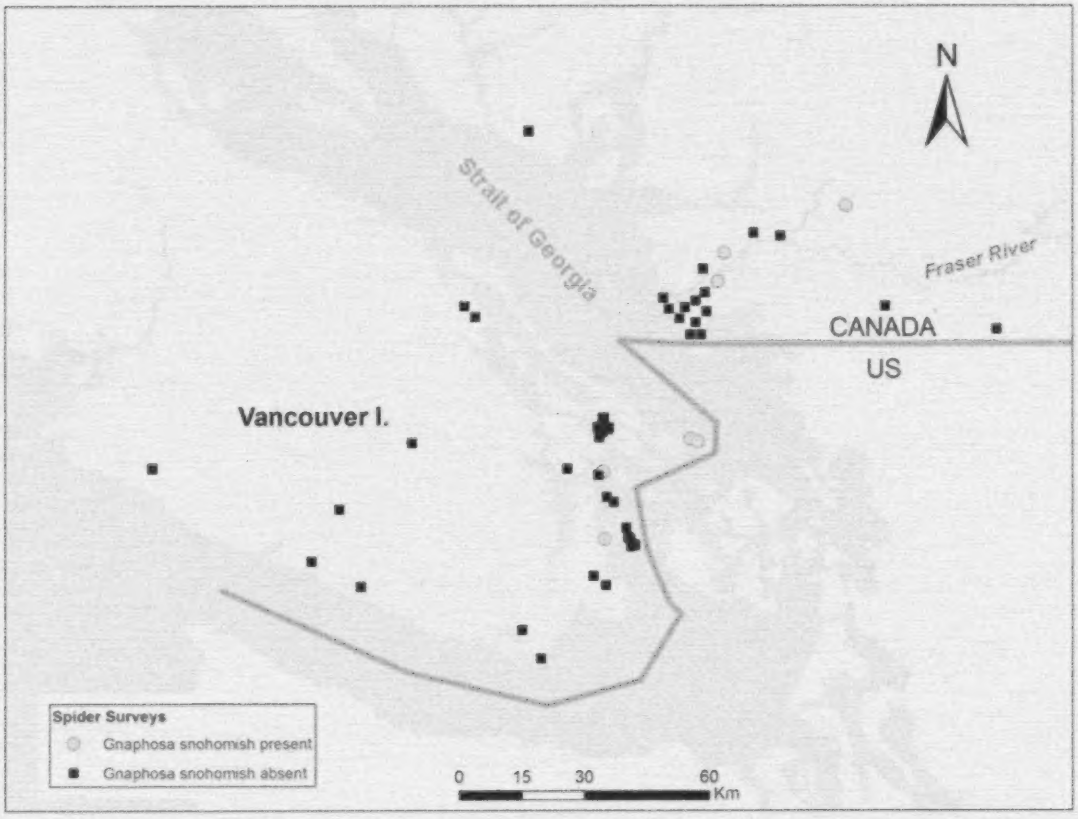

Figure 3. Georgia Basin Bog Spider survey effort in southwestern BC. Green dots include three sites (two on the Southern Gulf Islands, one on southeastern Vancouver Island) with presumably non-viable occurrences. See Table 1 and 2 and Figures 5, 8 and 9 for details.

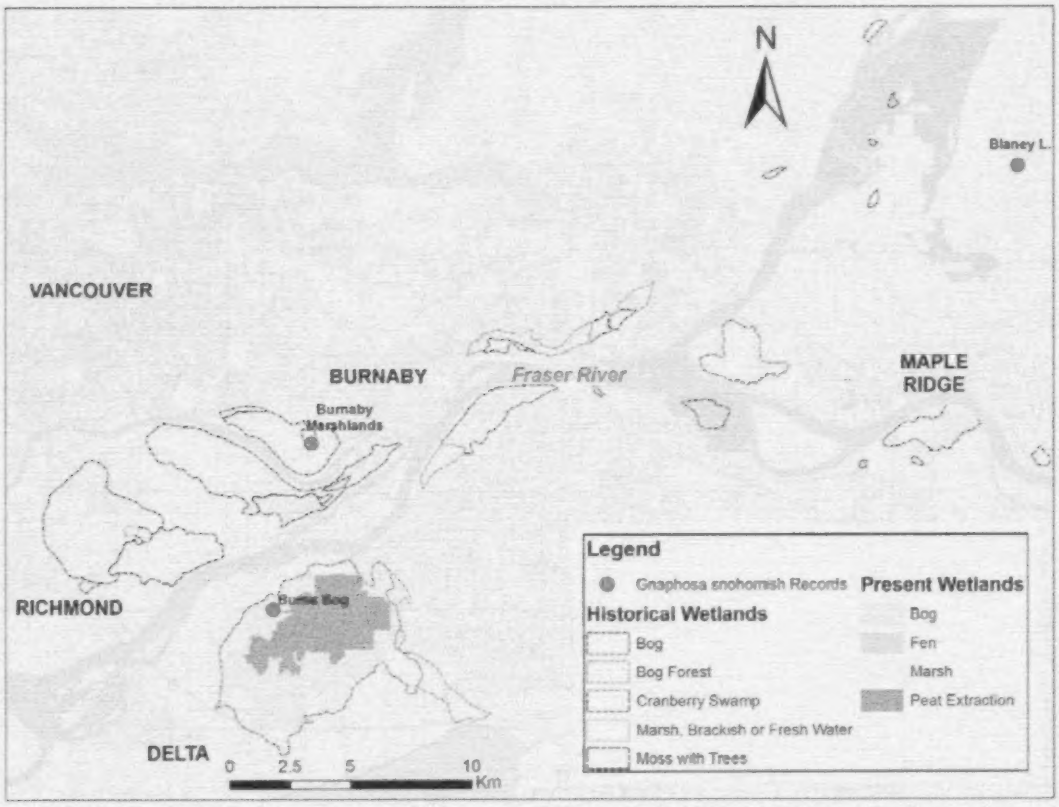

Figure 4. Records of Georgia Basin Bog Spider in the Lower Mainland (based on Bennett *et al.* 2006, R. Bennett pers. comm. 2011, 2010 fieldwork). Present and historical wetland data reproduced and distributed with the permission of Environment Canada.

Specimens of Georgia Basin Bog Spider were recently (2010-2011) identified from a series of pitfall trap collections from several Canadian Gulf Islands (Tumbo, Cabbage, and Portland Islands) in 1989 (J. Bergdahl pers. comm. 2011; R. Bennett pers. comm. 2011) and from southeastern Vancouver Island (Island View Beach) in 2003 (Bennett *et al.* 2006).

The Gulf Islands and Island View Beach sites occur within a 16 km radius (Figure 5, Table 1). All but one of the Canadian sites are at very low elevation, less than 10 m above sea level. Blaney Lake is at an elevation of about 350 m and is about 30 km east of the sites on the Fraser River Delta.

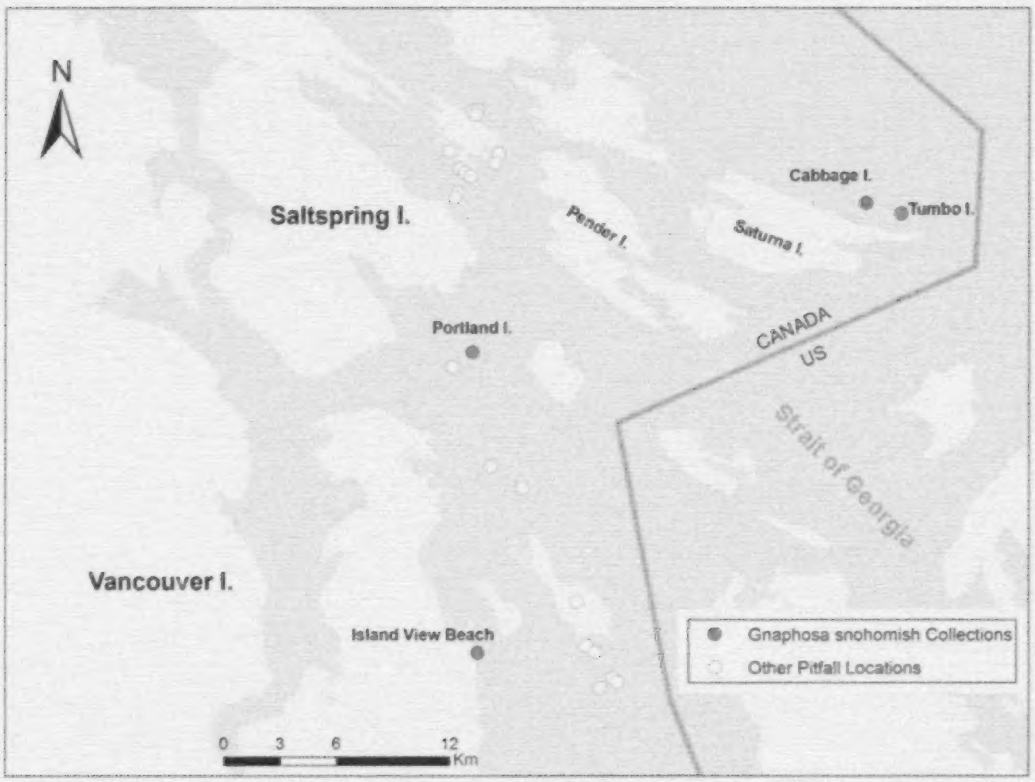

Figure 5. Records of Georgia Basin Bog Spider in the Canadian Gulf Islands Area (based on Bennett *et al.* 2006, R. Bennett pers. comm. 2011, J. Bergdahl pers. comm. 2011). Records at Island View Beach, Portland Island, and Cabbage Island are of single specimens and are believed to represent transient, non-viable occurrences.

Established populations likely do not exist at Cabbage Island, Portland Island, and Island View Beach. Only single specimens were collected at these locations despite several thousand pitfall trap nights over multiple months (Table 1). These occurrences may represent random dispersal by "ballooning" from the strong population at Tumbo Island (represented by 172 specimens) (R. Bennett pers. comm. 2011). Canadian populations of Georgia Basin Bog Spider almost meet the criteria of Severely Fragmented (International Union for Conservation of Nature 2010) given the isolation and apparent small size of most populations, but actual declines in numbers are not documented and isolation may not be complete. Ballooning may allow spiders to disperse between areas of suitable habitats (but see next paragraph and also refer to ***Dispersal and Migration***). Because they are likely to be transient occurrences, the records of single individuals on small Gulf Islands and Vancouver Island (Appendix 1, Figure 5) have not been included in the calculation of the total index of area of occupancy. The remaining Gulf Island occurrence is in a 15 ha cattail (*Typha* sp.) marsh.

There is no literature on dispersal capability of Georgia Basin Bog Spider. Many types of spiders, however, disperse over relatively wide areas by "ballooning" (Foelix 1996; see also references in Bennett 2003). Georgia Basin Bog Spider is apparently able to disperse between islands as supported by occurrences of single individuals in the southern Gulf Islands 20 to 30 km from known populations. However, successful dispersal by ballooning requires that ballooning individuals arrive at habitat suitable for their survival, and in sufficient numbers to allow successful reproduction. Suitable wetland habitat in the area is rare and covers a very small area (Boyle *et al.* 1997; Hebda *et al.* 2000; BC Conservation Data Centre 2012a, 2012b) and successful dispersal of Georgia Basin Bog Spiders to suitable habitat and in sufficient numbers for reproduction is expected to be a very rare occurrence (Bennett pers. comm. 2012). Because Cabbage Island, Portland Island, and Island View Beach are considered transient occurrences and all but one of the other known sites are at very low elevation and subject to saltwater inundation, there are 2 Canadian locations for Georgia Basin Bog Spider, one at Blaney Lake and the other including Burns Bog, Burnaby Marshlands, and Tumbo Island (Figures 8, 9).

Although future fieldwork in the Georgia Basin area may identify additional sites, the extensive pitfall trapping that has already been conducted in and around the area suggests that few new sites will be discovered, if any, and the Canadian range of Georgia Basin Bog Spider will likely remain unchanged.

Search Effort

Surveys in or in close proximity to appropriate wetland (peatlands and marsh) habitat within the range of Georgia Basin Bog Spider are summarized in Table 1. This species is likely to be captured only by pitfall trapping (especially males (Platnick and Shadab 1975)), hand collecting, or similar techniques (R. Bennett pers. comm. 2011).

Surveys targeting Georgia Basin Bog Spider have been conducted at Burnaby Marshlands by Jim Troubridge and at other sites by Robb Bennett and colleagues (Bennett *et al.* 2006; Bennett pers. comm. 2011). One or more of Bennett, Claudia Copley, and Darren Copley have surveyed Rithets Bog (fen and bog), Yellow Point Bog (a fen), Jordan River Bog, and Bowser Bog (a fen) (Vancouver Island), Chickadee Lake (fen on Denman Island), Brandywine Bog (near Whistler), and a southern Saltspring Island fen (as well as many of other sites with potentially suitable wetland habitat such as Schooner Cove, Harris Creek, Avatar Grove, Cheewhat River, Matheson Lake, Haliburton Farm, Cowichan River) by hand collecting and Berlese funnel litter sampling between 2008 and 2012 without finding specimens of Georgia Basin Bog Spider. Surveys for the present study were conducted in 2010 by A. Harris and R. Foster at Burns Bog, Richmond Nature Park, and Blaney Lake. Karen Needham unsuccessfully searched for Georgia Basin Bog Spider at the Burnaby Marshland in 2008. She has also conducted pitfall trapping at Burns Bog but the spider specimens have not yet been identified (K. Needham, pers. comm. 2010). In 1989, James Bergdahl collected Georgia Basin Bog Spider on several Canadian Gulf Islands (Tumbo, Portland, and Cabbage Islands). The spiders from the Bergdahl collections were identified in 2010 and 2011 by

Robb Bennett and Darren Copley (J. Bergdahl pers. comm. 2011; R. Bennett pers. comm. 2011). Additional pitfall trapping has been conducted in or near potentially suitable wetlands in southwestern BC, especially in and around the Victoria, Vancouver, Delta, and Surrey area (Table 1); none of those surveys produced Georgia Basin Bog Spiders (most but not all collections had been searched by August 2012 (R. Bennett pers. comm. 2012)).

Table 2 summarizes additional spider survey effort within or near the range of Georgia Basin Bog Spider. These collections were examined by Robb Bennett, but included no Georgia Basin Bog Spiders (R. Bennett pers. comm. 2011). Bergdahl operated pitfall traps on 19 other Gulf Islands in 1989, typically running a transect of traps through the range of habitat types present. In 2008, Melissa Todd led a study consisting of 2016 trap nights of pitfall sampling in mature (130-150 years old) and logged (10-15 years since harvest) Coastal Western Hemlock forest near Roberts Creek, BC (M. Todd pers. comm. 2011). Claudia Copley and others at the Royal British Columbia Museum conducted pitfall and malaise trapping at Rocky Point (1 year+) and Carmanah Valley (2 years) on southern Vancouver Island. A similar survey was conducted at Mount Cain (2 years), on northern Vancouver Island (C. Copley pers. comm. 2011).

Table 2. Additional pitfall trapping effort in non-peatland habitat types (including some marshes) in southwestern BC 1989 - 2012. Roberts Creek, Rocky Point, Carmanah Valley, Mount Cain, some Gulf Islands, Schooner Cove, Matheson Lake, Cheewhat River, Avatar Grove, Harris Creek, Cowichan River, and Haliburton Farm sites include or are close to various wetland habitats potentially suitable for Georgia Basin Bog Spider). No Georgia Basin Bog Spiders were found in these collections (R. Bennett pers. comm. 2011, 2012). Vouchers from all these studies are at Royal British Columbia Museum.

Site	Effort	Source
Roberts Creek, Sunshine Coast	96 traps set for 21 trap nights, for a total of 2016 trap nights in 2008	M. Todd pers. comm. 2011, R. Bennett pers. comm. 2011
Rocky Point, Vancouver Island	Several pitfall and ground Malaise traps for 1 year+	C. Copley, pers. comm. 2011, R. Bennett pers. comm. 2011
Carmanah Valley, Vancouver Island	Several ground Malaise traps for 2 years (excluding Jan and Feb)	C. Copley, pers. comm. 2011, R. Bennett pers. comm. 2011
Mount Cain, N. Vancouver Island	Several ground Malaise traps for 2 years (excluding Jan and Feb)	C. Copley, pers. comm. 2011, R. Bennett pers. comm. 2011

Site	Effort	Source
Gulf Islands:		
Brackman Island N Acland Island S Ackland Island Central Ackland Island Big D'Arcy Island Tiny D'Arcy Island Forrest Island S Hawkins Island E Hawkins Island N Hawkins Island Big Red Island Bright Island Glenthorne Island Big Sallas Island Little Sallas Island Sidney Island SW Dock Island Big Channel Island Little Channel Island	Many pitfall traps over several months in 1989	R. Bennett pers. comm. 2011, J. Bergdahl pers comm. 2011
Schooner Cove, nr. Tofino	Hand collecting (~3 hrs) and Berlese extraction of moss sample in 2010	R. Bennett unpub. data
Matheson Lake, Metchosin	Hand collecting (~8 hrs) and Berlese extraction of moss samples in 2010	R. Bennett unpub. data
Cheewhat River, Cloose	Hand collecting (~8 hrs) and Berlese extraction of moss samples in 2009 & 2010	R. Bennett unpub. data
Avatar Grove, Port Renfrew	Hand collecting (~6 hrs) and Berlese extraction of moss samples in 2012	R. Bennett unpub. data
Harris Creek, between Honeymoon Bay and Port Renfrew	Hand collecting (~3 hrs.) and Berlese extraction of moss sample in 2010	R. Bennett unpub. data
Cowichan River floodplain, nr. Skutz Falls	Berlese extraction of moss samples in 2010	R. Bennett unpub. data
Haliburton Farm, Saanich	Many nights of pitfall trapping, Berlese extraction of moss samples in 2011	R. Bennett unpub. data

Search Effort: Potential for Occurrences in Unsurveyed Wetlands

Unsurveyed wetlands (some of which may be appropriate habitat) exist within the Canadian range of Georgia Basin Bog Spider. For example, Hamilton Marsh (a bog) on Vancouver Island and Fraser/Pitt River islands (fens), Minnekhada Regional Park (a marsh), and Widgeon Creek (a marsh) on the Lower Mainland have not been surveyed (R. Bennett pers. comm. 2011).

Bogs are believed to provide the optimal habitat for Georgia Basin Bog Spider (Bennett *et al.* 2006). Perhaps 2300 ha of bog habitat remain in the Georgia Basin area, including approximately 1800 ha in the Lower Fraser Valley (Ward *et al.* 1992), 170 ha on eastern Vancouver Island and the southern Gulf Islands (Ward *et al.* 1998), and 235 ha on the Sunshine Coast (C. Cadrin, J. Kirkby pers. comms. 2012). Most of the Sunshine Coast and most of the few remaining eastern Vancouver Island bogs are outside of the known range of Georgia Basin Bog Spider (Bennett pers. comm. 2012)

(range description is believed to be accurate based on survey effort described above). Seven sites comprising about 75% of the Georgia Basin's total bog habitat have been surveyed; 3 sites with about 70% of the total bog habitat have (Burns Bog, Blaney Lake) or had (Burnaby Marshlands) Georgia Basin Bog Spider populations; populations do not occur at the remaining 4 sites (5 %,Table 1). Little if any of the remaining 25% (comprising very small and scattered bogs in the Georgia Basin) is expected to support populations of Georgia Basin Bog Spider because the spider is associated with extensive areas of habitat throughout its range and has not been found in numerous small areas surveyed.

Fens and marshes rarely provide habitat for Georgia Basin Bog Spiders. The physical structure of fens is generally similar to that of bogs. However, the botanical characteristics and water chemistry and flow differ markedly between fens and bogs and may make fens generally unsuitable. About 2400 ha of fens at 18 sites have been recorded in the Lower Fraser Valley (Ward *et al.* 1992). No Georgia Basin Bog Spiders were found among arthropods collected in pitfall trapping surveys conducted at or near four of those sites, three in the Boundary Bay area (Serpentine River and headwaters and north bank of Nikomekl River) and one along the lower reach of Coquitlam River (Table 1; R. Bennett pers. comm. 2012). Fens cover 540 ha at an undetermined number of sites on eastern Vancouver Island and the southern Gulf Islands (Ward *et al.* 1998). At least four of those fen sites (Yellow Point Bog, Bowser Bog, Chickadee Lake, and southern Saltspring Island) have been surveyed with negative results for Georgia Basin Bog Spiders (Table 1; R. Bennett pers. comm. 2012). About 560 ha of fens occur on the Sunshine Coast (J. Kirkby pers. comm. 2012) but almost all of this hectarage occurs outside of the range of Georgia Basin Bog Spider (Bennett pers. comm. 2012). Because of the differences between bogs and fens and the lack of specimens at any of the surveyed fen sites, no unsurveyed fens in the Georgia Basin area are expected to have populations of Georgia Basin Bog Spiders.

Most available data on marshes in the Georgia Basin do not separate out saline, brackish, and estuarine marshes (unsuitable habitat) from freshwater marshes (potentially suitable habitat). Freshwater marshes cover about 3300 ha in the Lower Fraser Valley (Ward *et al.* 1992); an undetermined number of these co-occur with fens (e.g., along the Serpentine and Nikomekl Rivers) and many are in the eastern reaches of the Valley, outside of the range of Georgia Basin Bog Spider, or are unsuitable habitat such as seasonally flooded agricultural fields. A further 1800 ha of marshes occur on eastern Vancouver Island and the southern Gulf Islands (Ward *et al.* 1998), and about 240 ha on the Sunshine Coast (J. Kirkby pers. comm. 2012); an undetermined number of those marshes are unsuitable habitat (e.g., saline or estuarine) or are outside of the range of Georgia Basin Bog Spider.

Except for the single population record in the Tumbo Island cattail marsh (as well as single collections at Island View Beach, Portland Island, and Cabbage Island), extensive pitfall trapping adjacent or close to freshwater marshes within the distribution of Georgia Basin Bog Spider have produced no specimens (Table 2; e.g., Surrey, Delta, Coquitlam, other Lower Mainland sites, and various Gulf Islands and southern and

eastern Vancouver Island sites). Similarly, no specimens were recovered in extensive pitfall trapping in areas with potentially suitable marsh habitat but outside of the spider's distribution (Table 2; e.g., Roberts Creek, Carmanah Valley, Mt. Cain, Rocky Point, various southern and eastern Vancouver Island sites).

Because there is confidence in a restricted range (Figure 2) and there has been an extensive pitfall trapping and hand collecting effort within and near potentially suitable habitat within and near the spider's range, there are unlikely to be additional sites discovered. If any are discovered it is very unlikely that there would be more than 10 additional sites. Because all but 1 of the existing sites are near sea level, any additional sites are likely to be near sea level as well. Thus an increase in number of sites seems unlikely to result in an increase in the number of locations as defined here on the basis of threat (saltwater incursion).

HABITAT

Habitat Requirements

Georgia Basin Bog Spider is primarily a peatland species (tryphobiontic) (Bennett *et al.* 2006); a cattail (*Typha* sp.) marsh on one of the southern Gulf Islands is the only known Canadian site for an established population associated with a wetland other than a bog. In BC, 3 of the 4 viable sites are bog habitats and within the lower mainland at elevations from sea level to 350 m. In Washington, 6 of the 7 sites are bogs at elevations from sea level to 800 m (Bennett *et al.* 2006). All non-bog occurrences (except for the cattail marsh site) of this spider are of single specimens, likely the result of random ballooning events, and not indicative of established populations.

Burns Bog is a raised bog ecosystem covering about 3000 ha on the Fraser River delta. About half of the bog is in a relatively natural state with *Sphagnum* moss, ericaceous shrubs, and other bog vegetation (Ward *et al.* 1992; Hebda *et al.* 2000). The remaining half of the bog was formerly used for peat extraction, landfill, and other uses and was extensively drained. Vegetation of the former peat workings is dominated by coniferous forest, ponds, and sedge- and grass-dominated communities (Hebda *et al.* 2000). Habitat at the 2010 sampling points consisted of scattered short Lodgepole Pine (*Pinus contorta*) with ericaceous shrubs (*Andromeda polifolia*, *Vaccinium cespitosum*), and a carpet of *Sphagnum* (Figure 6). This habitat is classified as site association Wb02 (Lodgepole Pine - Bog Rosemary - *Sphagnum* Bog) (MacKenzie and Moran 2004).

Figure 6. Georgia Basin Bog Spider habitat at Burns Bog, British Columbia May 26 2010. Site association Wb02: Lodgepole pine-Bog rosemary-Peat-moss) MacKenzie and Moran 2004). Looking north. Photo by Allan Harris.

At Blaney Lake, Georgia Basin Bog Spider habitat consisted of a floating mat peatland surrounding a small lake. Vegetation was dominated by Sweet Gale (*Myrica gale*), Bog Rosemary (*Andromeda polifolia*) with Skunk Cabbage (*Lysichiton americanum*) and sedges (*Carex* sp.) (site association Wb50; Labrador Tea - Bog Laurel - *Sphagnum* Bog) (MacKenzie and Moran 2004) (Figure 7). The total area of peatland at this site is < 3 ha.

Figure 7. Georgia Basin Bog Spider habitat at Blaney Lake, British Columbia May 2010. Site association Wb50: Labrador tea-Bog laurel-Peat-moss (MacKenzie and Moran 2004). Looking east. Photo by Allan Harris.

The Burnaby Marshlands site is a former commercial cranberry farm that was abandoned for over 15 years prior to the 1998 study that resulted in the discovery of Georgia Basin Bog Spider there (Bennett *et al.* 2006). Vegetation consisted of hummocks of *Sphagnum* and other mosses with cranberry (*Vaccinium oxycoccos*), Round-leaved Sundew (*Drosera rotundifolia*), rushes (*Juncus* spp.), and grasses (Bennett *et al.* 2006). The site was redeveloped as a commercial cranberry farm shortly after completion of the 1998 study (R. Bennett pers. comm. 2011).

The Vancouver Island and Gulf Islands sites are associated with non-bog wetland complexes and marshes. The single Island View Beach specimen was collected close to a *Potentilla* marsh (Bennett *et al.* 2006). The Tumbo Island specimens were collected in a cattail marsh covering about 15 ha. The single Cabbage Island specimen was from a marsh covering about 1 ha. Habitat at the Portland Island site is unknown (J. Bergdahl pers. comm. 2011; R. Bennett pers. comm. 2011).

Habitat Trends

Historically, 21 bogs occurred in the Fraser River delta (Hebda *et al.* 2000), the largest of which include Burns Bog, Burnaby Bend Bog (including the Burnaby Marshlands), and Lulu Island bogs. Since the mid-1800s, over 50% of the bog habitat has been lost to agriculture, peat extraction, drainage, and urban encroachment (Davis and Klinkenberg 2008). Much of the remainder is degraded by altered hydrology, invasive species, and lack of connectivity. In 1998 the Fraser Valley contained 2371 ha of mapped bog wetland; Burns Bog accounts for 80% of the mapped bog area (Ward *et al.* 1998).

Burns Bog is the largest and most intact peatland ecosystem in the Fraser River delta (Ward *et al.* 1998; Hebda *et al.* 2000). Although most of the bog has been lost or disturbed by peat extraction and related activities, about 30% has relatively intact vegetation and hydrological processes (Hebda *et al.* 2000; MetroVancouver 2009). In 2004, 2042 hectares of Burns Bog (about 40% of the original bog area) were purchased by federal, provincial and municipal governments and are now managed to maintain and restore a functional raised bog ecosystem (Metro Vancouver 2009). Historical drainage lowered the water table throughout Burns Bog and promoted the succession of native pines and hemlock as well as invasive non-native species (R. Hebda pers. comm. 2011). Attempts to restore hydrological processes by blocking drainage ditches are hoped to slow natural succession of woody native plants and invasion by non-native species and enable good conditions for *Sphagnum* growth. Preliminary monitoring suggests *Sphagnum* regeneration is occurring in former peat extraction areas of the central bog (R. Hebda pers. comm. 2011). The portions of Burns Bog outside the protected area are being converted to cranberry farms and urban development (F. Lomer pers. comm. 2011).

Most of the Lulu Island Bog (historically covering most of the City of Richmond and a small portion of the City of New Westminster) has been converted to urban and agricultural development. Historical drainage has probably been the cause of the succession of the remaining natural areas from open heath-dominated vegetation to bog forest (Davis and Klinkenberg 2008). Remaining bog habitat occurs at the Richmond Nature Park (~ 50 ha) and nearby Department of National Defence lands (~ 50 to 100 ha) but apparently has been heavily invaded by woody plants in recent decades (A. Harris and R. Foster pers. obs. 2010).

About 95% of the Burnaby Bend Bog, including the Burnaby Marshlands site (Figure 4), has been developed for urban, industrial and agricultural purposes (Hebda *et al.* 2000). Bog Forest Marshland Conservancy Area (City of Burnaby Parks), a small (9 ha) green space on the north shore of the Fraser River close to the Burnaby Marshlands site may continue to support Georgia Basin Bog Spider habitat, but is also being invaded by native and exotic woody species (Bennett *et al.* 2006).

In contrast with the other peatlands, the bog at Blaney Lake appears to be in good condition and relatively intact, likely due to the absence of ditches, roads, and other anthropogenic disturbance. Natural forest succession or invasion by exotic plants do not yet appear to be changing the habitat at this site (A. Harris and R. Foster pers. obs. 2010).

Burnaby Marshlands and unprotected portions of Burns Bog will likely be lost due to development, invasive or exotic plant species and/or natural forest succession. The protected portion of Burns Bog also has forest succession and invasives issues but loss of *Sphagnum* habitat is expected to stabilize following restoration of hydrology. Habitat in the Gulf Islands, Island View Beach, and Blaney Lake sites does not face imminent threats but occurs as small and isolated patches subject to stochastic events (e.g., inclusive regional events such as saltwater inundation during tsunamis or winter storm surges).

Development throughout the lower Fraser Valley from the 1820s to 1996 resulted in an 85% reduction of wetland cover (including seasonally flooded lowland swampy and marshy land) from approximately 10% to less than 1.5% (Boyle *et al.* 1997; BC Ministry of Water, Land and Air Protection 2002). There are few wet meadows, fen, bog and shallow water wetlands on Vancouver Island and the Gulf Islands (Ward *et al.* 1998; C. Cadrin pers. comm. 2012) with a total of 171.8 ha of bog wetlands mapped in the area (McPhee *et al.* 2000). Only one bog (Rithet's Bog) remains of seven once found in the Saanich (Victoria) area (McPhee *et al.* 2000) and only 6 hectares of non-forested bog and 152 hectares of forested bog are recorded within the Coastal Douglas-fir Biogeoclimatic Zone (Madrone Environmental Services Ltd. 2008; C. Cadrin pers. comm. 2012).

BIOLOGY

Life Cycle and Reproduction

In general, the life cycles of gnaphosid spiders are poorly understood because of the secretive habits of most species. *Gnaphosa* spiders are primarily nocturnal hunters and remain under cover during the day under leaf litter, bark, rocks, or in tubular retreats (Platnick and Shadab 1975).

Based on pitfall trap collection records (Bennett *et al.* 2006; R. Bennett pers. comm. 2011; Table 1) Georgia Basin Bog Spider likely has a one year life span. The species overwinters in the subadult stage and matures in early spring. Adult males become less common by early summer; adult females are generally present for most of the year (R. Bennett pers. comm. 2011). As in most spider species, a mature male spins a small sperm web, deposits a drop of sperm on it, and transfers it to the genital bulbs of his palpi prior to courtship of females and mating (Platnick and Dondale 1992). Courtship of Georgia Basin Bog Spider has not been observed. A female may produce and guard one or more flattened silk egg sacs, each containing up to 250 eggs (Platnick and Shadab 1975).

Physiology and Adaptability

Although Georgia Basin Bog Spider is primarily a bog specialist (Bennett *et al.* 2006), at four of the seven Canadian sites the species has been recorded in other types of wetlands. There is no information on the physiology of this species.

Dispersal and Migration

Dispersal of spiders by aerial ballooning, often seasonally and in huge numbers, is common in many spider families (Greenstone *et al.* 1987; Foelix 1996; Bennett 2003; R. Bennett pers. obs.). Ballooning involves climbing to an elevated perch, facing into a light breeze, and extruding silk threads which are caught in an updraft and carry the spider away (Foelix 1996). Spiders are sometimes carried great distances (>100 km) and this explains the rapid colonization by spiders of volcanoes after devastating eruptions such as at Krakatoa (Greenstone *et al.* 1987; Foelix 1996) and Mt. St. Helens (Edwards and Sugg 2005). Dispersal by ballooning is random and affected by local environmental conditions such as wind speed and direction, temperature, relative humidity. Successful dispersal by ballooning requires that ballooning individuals arrive at habitat suitable for their survival, and in sufficient numbers to allow reproduction. Therefore, the probability of success for an individual ballooning spider (and consequently, the likelihood of establishment of a new population) is extremely low, especially for species such as Georgia Basin Bog Spider that requires specialized or very rare habitats (Bennett pers. comm. 2012).

Although ballooning has not been documented in Georgia Basin Bog Spider, other Gnaphosidae balloon (e.g., Greenstone *et al.* 1987) and the occurrence of single individuals at Cabbage Island, Portland Island, and Island View Beach suggests that they ballooned to those sites from the larger population at Tumbo Island or farther afield (R. Bennett pers. comm. 2011). An alternative means of dispersal between islands is movement on driftwood (Foelix 1996) and by boat. Bogs were formerly more widespread and this may have facilitated dispersal of Georgia Basin Bog Spiders historically.

Interspecific Interactions

Interspecific interactions for Georgia Basin Bog Spider have not been documented, but are probably similar to those of other ground-dwelling spiders. Ground spiders do not capture prey with webs, but actively pursue their prey on the ground. Prey species include insects and other spiders. Spider wasps (order Hymenoptera, family Pompilidae) are among the most significant predators on spiders (Gertsch 1979; Foelix 1996). Other predators of spiders include insects, other spider species, frogs, birds and small mammals such as shrews. Fungal infections and nematodes often affect spiders (Gertsch 1979; Foelix 1996).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Pitfall trapping appears to be the most effective method of sampling Georgia Basin Bog Spider (Platnick and Shadab 1975; Bennett pers. comm. 2011). Pitfall trapping surveys within the range of this species were completed in 1998 (Troubridge *et al.* 1998), 2003 and 2004 (Bennett *et al.* 2006), and 2010 (A. Harris and R. Foster pers. comm. 2011). Sampling effort in those studies is summarized in Table 1.

The 2010 pitfall trap survey completed to support this status report used trap grids of 10 pitfalls in a 5 x 2 arrangement with 1 metre between traps. The pitfall consisted of a plastic cup measuring 10 cm in diameter at the mouth and 15 cm deep. The cup was sunk to the lip in the peat and about 3 cm of propylene glycol was added. The traps were checked after 2 to 3 days. Other surveys listed in Table 1 used similar techniques (Bennett *et al.* 2006; R. Bennett pers. comm. 2011).

Abundance

Abundance estimates are unavailable for Georgia Basin Bog Spider. It is not possible to estimate population size accurately from existing pitfall trapping, Berlese extraction, or hand-collecting data given the unknown variables of mobility, escapement, microhabitat relationships, seasonality, and effects of weather.

Fluctuations and Trends

No analysis of population trends or fluctuations is available for Georgia Basin Bog Spider. Based on collection records, the Blaney Lake population has apparently persisted for at least 42 years (1968 to 2010). It is not possible to extrapolate fluctuations or trends based on past sampling effort and no population monitoring has been conducted. The largest recorded population of Georgia Basin Bog Spider (in part of the Burnaby Marshlands site) was destroyed in the late 1990s (Bennett pers. comm. 2011).

Rescue Effect

Rescue is possible. There is a minimum distance of about 45 km from the nearest known US populations to the Canadian border. Potential habitat exists in intervening areas and could provide linkages between the US and Canada. Occurrences of single individuals at Island View Beach and Portland Island suggest that dispersal by ballooning may occur over distances of at least 20 to 30 km (R. Bennett pers. comm. 2011).

THREATS AND LIMITING FACTORS

The most significant and immediate threat to Georgia Basin Bog Spider is climate change and severe weather. Natural system modifications also rank high. The spider is also threatened by development, agriculture, pollution, invasive species and geological events. Most of the known Georgia Basin Bog Spider sites are in parks or other protected areas and therefore receive some degree of protection from residential, industrial and agricultural development. However, the species has no formal recognition in land management plans and wetland habitat is subject to alteration as a result of changes to the water table in the surrounding area. An assessment of threats using the "Threats Assessment Worksheet" produced by NatureServe (Master *et al.* 2009) resulted in an overall threat impact of "very high." In the following list, the first number indicates the order of importance of the threat and the second bracketed number is the corresponding number from the worksheet. Following IUCN criteria ("4.1 Location" in IUCN Standards and Petitions Subcommittee 2010), the highest priority threat (number 1) establishes two locations: sites at or slightly above sea level, and Blaney Lake which is above sea level.

Climate Change & Severe Weather

Coastal wetland habitat in British Columbia is expected to be lost because of rising sea levels and severe weather storm surges associated with ongoing climate change: "The best available science suggests that the impacts for B.C. in the 21st century will include increased river flood risks in the spring and coastal flooding associated with storm surges" (BC Ministry of Environment 2012). With the possible exception of Blaney Lake, all Georgia Basin Bog Spider sites in BC are at very low elevation (within 1 m of sea level) and consequently at risk to the effects of climate change and increasingly severe weather impacts. Although some raised bog habitat is 3-5 m above sea level, this would be affected to some extent by lesser inundation due to "sponge effects" (R. Hebda pers. comm. 2012).

Some information is available on recent storm effects on areas immediately adjacent to Burns Bog (Forseth 2012) including the 1982 extreme tide event in Vancouver when water levels breached dykes and flooded King George highway although the storm surge and high tide were not fully coincidental. The 2006 surge caused extensive seawater inundation in the Boundary Bay area. By 2100 there may be a rise of 1.2 m in sea level in the Fraser delta (Thomson *et al.* 2008, Kangasniemi 2009). With waves and surges along the way to attaining this substantially increased sea level, salt water inundations are likely to have increasing impact.

Natural System Modifications

Vegetation succession related to drainage of peatlands and invasive native and exotic plants are ongoing threats. Destruction of wetlands is ongoing; 85% of wetlands in the Lower Fraser Valley were destroyed between 1827 and 1996 (Boyle *et al.* 1997; BC Ministry of Water, Land and Air Protection 2002) and bogs (the primary habitat for this spider) are rare and rapidly declining in southern BC (Boyle *et al.* 1997; Hebda *et al.* 2000; BC Conservation Data Centre 2012a, 2012b). Lowered water tables associated with recent and historical drainage programs have altered the hydrology of many of the remaining peatlands in the Fraser River delta and contributed to the conversion of open heath habitat to conifer forest. As the percent ground cover of native species such as Lodgepole Pine and Salal (*Gaultheria shallon*) increases, *Sphagnum* cover declines (Hebda *et al.* 2000); drainage has accelerated the process and contributed to the degradation of bog habitat.

Pollution

Heavy industrial, agricultural, and residential development has resulted in real or potential pollution of wetlands throughout the lower Fraser Valley. Of known Georgia Basin Bog Spider sites in the Fraser Valley, only Blaney Lake is not apparently affected by pollution. Burns Bog is subject to pollution from surrounding development, major roads, and a major City of Vancouver garbage disposal site (AGRA Earth and Environmental Limited 1999). Burnaby Marshlands is subject to pollution from an adjacent heavily developed transportation corridor.

Invasive Species

Invasive non-native plants are present in most of the Fraser River delta bogs. Among the most significant invasive plants threatening bog habitats are Highbush Blueberry (*Vaccinium corymbosum*), Scotch Heather (*Calluna vulgaris*), European Birch (*Betula pendula*), Tawny Cottongrass (*Eriophorum virginicum*), and Large Cranberry (*Oxycoccus macrocarpus*) (Hebda *et al.* 2000; Davis and Klinkenberg 2008). These species can alter bog vegetation structure and contribute to shading of *Sphagnum* (Hebda *et al.* 2000; R. Hebda pers. comm. 2011; F. Lomer pers. comm. 2011).

Agriculture

Bog and peatland habitats outside protected areas are at risk of agricultural development. Conversion of the Burnaby Marshlands site to a commercial cranberry farm may have caused extirpation of the largest known Canadian population of Georgia Basin Bog Spider.

Residential & Commercial Development

Many of the remaining natural wetland areas in the lower Fraser Valley are surrounded by urban and industrial development (existing or planned) and there is an increase in proposed development projects that involve infilling, diverting or channeling existing natural water courses to accommodate access among urban and industrial developments. For example, the proposed South Fraser Perimeter Road may have severe adverse impacts on Burns Bog (Burns Bog Conservation Society 2012).

Geological Events

The coasts of southwestern British Columbia, Washington, Oregon, and northern California are adjacent to the active Cascadia subduction zone which separates the Juan de Fuca, Explorer, Gorda, and North American tectonic plates; historically the area has experienced severe "megathrust" earthquakes (magnitude 9.0 or greater) and resultant low elevation saltwater flooding and habitat destruction from tsunamis and/or land subsidence (references in Thompson 2011). With the possible exception of Blaney Lake, all Georgia Basin Bog Spider sites in BC are at risk of earthquake-induced habitat destruction.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

COSEWIC assessed the Georgia Basin Bog Spider as Special Concern in November 2012. Currently, Georgia Basin Bog Spider is not legally protected in any jurisdiction in Canada or the US. It may achieve some indirect protection through wetland conservation and protection stipulated by the *BC Water Act* and the *Riparian Areas Regulation of the BC Fisheries Act*. These habitat protection mechanisms, however, do not guarantee protection of the spider.

Non-Legal Status and Ranks

Georgia Basin Bog Spider has not been formally assigned conservation status ranks at the global, national or subnational levels in Canada or the US (M. Anions pers. comm. 2011; NatureServe 2012). Provisional, unpublished global (G2 – Globally Imperiled) and national (N2 – Nationally Imperiled) ranks, however, have been drafted in Canada (M. Anions pers. comm. 2011). This species is not yet ranked by the BC Conservation Data Centre (2011) although it will likely be ranked S1 or S1S2 in BC (L. Ramsay pers. comm. 2012; L. Gelling pers. comm. 2012).

Habitat Protection and Ownership

Tumbo Island is within Gulf Islands National Park. Part of Tumbo Island is zoned as *Wilderness*, where the priority is to "maintain ecosystems in a wilderness state" (Parks Canada 2011). Approximately one third of Tumbo Island is zoned as Special Protection (priority is protection of natural or cultural features; human activity may be restricted) (Parks Canada 2011). Currently (2012) there is no specific policy for the protection of Georgia Basin Bog Spider within the Gulf Islands National Park Reserve.

Burnaby Marshlands (Figure 4) is a privately owned commercial cranberry farm within the municipality of Burnaby that was developed from an abandoned peat extraction site in 1998 (Bennett *et al.* 2006). Marshland Bog Forest Reserve (a City of Burnaby conservation area) is a small portion (9 ha) of the original bog protected within the Fraser River Estuary Management Program (City of Burnaby 2012). There is, however, no municipal policy for the protection of Georgia Basin Bog Spider within the Reserve currently (2012).

In March 2004, 2042 hectares of Burns Bog were purchased by federal, provincial and municipal governments and became the Burns Bog Ecological Conservation Area. It is being managed to maintain and restore a functional raised bog ecosystem (MetroVancouver 2009). Although Burns Bog lands managers are aware of the presence of Georgia Basin Bog Spider and its habitat needs (M. Merkens pers. comm. 2010), there is no formal policy in place for its protection at Burns Bog.

Blaney Lake is within the University of British Columbia's Malcolm Knapp Research Forest which has a mandate of "research, demonstration, and education in the field of forestry and allied sciences" (University of British Columbia 2011). Although UBC lands managers are aware of the presence of Georgia Basin Bog Spider and its habitat needs (I. Aron pers. comm. 2010), currently (2012) there is no formal policy in place for its protection at Blaney Lake.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

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INFORMATION SOURCES

AGRA Earth & Environmental Limited. 1999. Burns Bog ecosystem review. Contaminated soils/water. Delta, British Columbia. Web site: http://a100.gov.bc.ca/appsdata/epic/documents/p60/1036434453346_16af42884ae64e0f8553d621be48be92.pdf. [Accessed January 2012.]

Anions, M. 2011. Email correspondence to A. Harris. October 2011.

Aron, I. Email correspondence to A. Harris. April 2010.

BC Conservation Data Centre. 2011. Species and ecosystems explorer. http://a100.gov.bc.ca/pub/eswp/. [Accessed May 2, 2011.]

BC Conservation Data Centre. 2012a. Ecological community summary: *Ledum groenlandicum / Kalmia microphylla / Sphagnum* spp. BC Ministry of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ {accessed Jan 4, 2012.]

BC Conservation Data Centre. 2012b. Ecological Community Summary: *Pinus contorta / Sphagnum* spp. *Very Dry Maritime*. B.C. Ministry of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ [Accessed Jan 4, 2012.]

BC Ministry of Environment. 2012. Climate change: provincial impacts. Web site: http://www.env.gov.bc.ca/cas/impacts/bc.html. [Accessed January 2012.]

BC Ministry of Water, Land and Air Protection. 2002. Environmental indicator: habitat in British Columbia. Web site: http://www.env.gov.bc.ca/soe/et02/14_habitat/technical_report/Habitat_2002.pdf. [Accessed January 2012.]

Bennett, R.G. 2003. Mass dispersal of spiders from a clover field in British Columbia, Canada. Newsletter of the British Arachnological Society 97:2-5.

Bennett, R.G, Fitzpatrick, S.M., and Troubridge, J.T. 2006. Redescription of the rare ground spider *Gnaphosa snohomish* (Araneae: Gnaphosidae), an apparent bog specialist endemic to the Puget Sound / Georgia Basin area. Journal of the Entomological Society of Ontario 137:13-23.

Bennett, R. 2011. Multiple email correspondence to A. Harris. May 2009 to April 2011.

Bennett, R. 2012. Discussions with COSEWIC Arthropods Specialists Subcommittee members, July & August 2012.

Bergdahl, J. 2011. Email correspondence to A. Harris. February 2011.

Boyle, C.A., Lavkulich, L., Schreier, H. and Kiss, E. 1997. Changes in land cover and subsequent effects on Lower Fraser Basin Ecosystems from 1827 to 1990. Environmental Management. 21:185-196. (Hebda *et al.* 2000; BC Conservation Data Centre 2012a, 2012b)

Burns Bog Conservation Society. 2012. South Fraser perimeter road. Web site: http://www.burnsbog.org/get-involved/campaigns. [Accessed January 2012.]

Cadrin, C. 2012. Email correspondence to J. Heron. Summer 2012.

City of Burnaby. 2012. Parks and Conservation Areas web site http://www.burnaby.ca/City-Services/Policies--Projects---Initiatives/Environment/Environmental-Policies-and-Regulations/Parks-and-Conservation-Areas.html. [Accessed January 2012.]

Committee on the Status of Endangered Wildlife in Canada. 2011. Web site: http://www.cosewic.gc.ca/eng/sct2/sct2_1_e.cfm. [Accessed March 2011.]

Copley, C. 2011. Email correspondence to A. Harris. April 2011.

Davis, N., and Klinkenberg, R. (editors). 2008. A biophysical inventory and evaluation of the Lulu Island bog, Richmond, British Columbia. Richmond Nature Park Society, Richmond, British Columbia.

Demarchi, D.A. 2011. The British Columbia ecoregion classification. Third Edition. Web site: http://www.env.gov.bc.ca/ecology/ecoregions/index.html [accessed September 2012].

Edwards, J.S., and Sugg, P.M. 2005. Arthropods as pioneers in the regeneration of life on the pyroclastic-flow deposits of Mount St. Helens. *In* V.H. Dale, F.J Swanson, and C.M Crisafulli (eds.). Ecological Responses to the 1980 Eruption of Mount St. Helens. New York Springer-Verlag. pp. 127–138.

Foelix, R.F. 1996. Biology of Spiders. Second Edition. Oxford University Press.

Forseth, P. 2012. Adaptation to sea level rise in Metro Vancouver: a review of literature for historical sea level flooding and projected sea level rise in Metro Vancouver. The Adaptation to Climate Change Team: Session #6: Adaptations to sea level rise. http://act-adapt.org/wp-content/uploads/2011/06/ACT_SLR_Literature-Review_250212.pdf

Gelling, L. 2012. Email correspondence to J. Heron. Summer 2012.

Gertsch, W.J. 1979. American Spiders. Second Edition. Van Nostrand Reinhold Company.

Greenstone, M.H., Morgan, C.E., and Hultsh, A.-L. 1987. Ballooning spiders in Missouri, USA, and New South Wales, Australia: family and mass distributions. The Journal of Arachnology. 15:163–170.

Harris, A. 2011. *Email correspondence to R. Bennett*. March 2011.

Hebda, R.J. 2011. *Email correspondence to A. Harris*. April 2011.

Hebda, R.J., Gustavson, K., Golinski, K., and Calder, A.M. 2000. Burns Bog ecosystem review synthesis report for Burns Bog, Fraser River Delta, southwestern British Columbia, Canada. Environmental Assessment Office, Victoria, BC.

Heron, J. 2011. Email correspondence to A. Harris. July 2011.

Howie, S. 2002. A look at Burns Bog. Davidsonia 13(4):76 – 94. 706 Web site: http://www.davidsonia.org/files/13_4_burnsbog.pdf Accessed April 2011.

International Union for Conservation of Nature Standards and Petitions Subcommittee. 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010. Web site: http://intranet.iucn.org/webfiles/doc/SSC/RedList/ RedListGuidelines.pdf. [Accessed March 2011.]

IUCN Standards and Petitions Subcommittee. 2010. Guidelines for using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010. http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf

Kangasniemi, B. 2009. Climate change impacts for the coastal B.C. Tsawwassen Area Plan Review Publiv Forum #3: Adapting to a Changing Climate. October 6, 2009. Climate Action Secretariat, B.C. Ministry of Environment. http://www.corp.delta.bc.ca/asets/CPD/PDF/public_forum_presentation_moe.pdf

Kirkby, J. 2012. Email correspondence to R. Bennett. July 2012.

Lomer, F. 2011. Email correspondence to A. Harris. April 2011.

MacKenzie, W.H., and Moran, J.R. 2004. Wetlands of British Columbia: a guide to identification. Research Branch, BC Ministry of Forests, Victoria, BC Land Management Handbook No. 52.

Madrone Environmental Services Ltd. 2008. Report: terrestrial ecosystem mapping of the Coastal Douglas-Fir Biogeoclimatic Zone. Web site: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=15273. [Accessed March 2011.]

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NaturServe Conservation Status Assessments: Factors for Assessing Extinction Risk. NaturServe, Arlington, VA. "Threats Assessment Worksheet" in Naturserver Conservation Status Assessments: Rank Calculator Version 2.0 Excel Worksheet available at http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.jsp. The use of the calculator is described in Master et al. (2009) and at the IUCN-CMP: The Conservation Measures Partnership web site http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies/threats-taxonomy/.

McPhee, M., Ward, P., Kirkby, J., Wolfe, L., Page, N., Dunster, K., Dawe, N.K., and Nykwist, I. 2000. Sensitive ecosystems inventory: east Vancouver Island and Gulf Islands, 1993 - 1997. Volume 2: Conservation Manual. Technical Report Series No. 345, Canadian Wildlife Service, Vancouver, BC.

Merkens, M. 2011. Email correspondence to A. Harris. April 2011.

MetroVancouver. 2009. Burns Bog Ecological Conservancy Area management plan May 2007. Web site: http://www.metrovancouver.org/about/publications/Publications/BurnsBogManagementPlan.pdf. [Accessed February 2011.]

NatureServe. 2012. NatureServe Explorer: an online encyclopedia of life . Version 6.1. NatureServe, Arlington, Virginia. Web site: http://www.natureserve.org/explorer. [Accessed March 2011.]

Needham, K. 2010. Email correspondence to A. Harris. April 2010.

Parkinson, L., Heron, J., Lavallee, S., Caldicott, A., Bains, B., and Blanchette, S.A. 2009. Surveys for three invertebrate species at risk in southwestern British Columbia: Oregon forestsnail (*Allogona townsendiana*), Audouin's night-stalking tiger beetle (*Omus audouini*) and *Copablepharon absidum* (unnamed noctuid moth), 2009. BC Ministry of Environment, Victoria, BC.

Parkinson, L. and Heron, J. 2010. Surveys for two invertebrate species at risk in southwestern British Columbia: Audouin's Night-stalking Tiger Beetle (*Omus audouini*) and Oregon Forestsnail (*Allogona townsendiana*). BC Ministry of Environment Victoria, BC.

Parks Canada. 2011. Gulf Islands National Park. Web site: http://www.pc.gc.ca/pn-np/bc/gulf/plan/plan1e.aspx. [Accessed February 2011.]

Platnick, N.I., and Dondale, C.D. 1992. The insects and arachnids of Canada. Part 19. The ground spiders of Canada and Alaska (Araneae: Gnaphosidae). Agriculture Canada Publication 1875. 297 p.

Platnick, N.I., and Shadab, M.U. 1975. A revision of the spider genus *Gnaphosa* (Araneae, Gnaphosidae) in America. Bulletin of the American Museum of Natural History. 155 (1):1-72.

Ramsay, L. 2012. E-mail correspondence to J. Heron. Summer 2012.

Thompson, J. 2011. Cascadia's fault. HarperCollins, Toronto. 329 p.

Thomson, R.E., B.D. Bornhold, and S. Mazzotti. 2008. An examination of the factors affecting relative and absolute sea level in coastal British Columbia. Canadian Technical Report of Hydrography and Ocean Sciences 260. 49 pp.

Todd, M. 2011. Email correspondence to A. Harris. February 2011.

Troubridge, J., Fitzpatrick, S., Bennett, R.G., and Catling, P. 1998. Pestiferous and predatory arthropods on an abandoned cranberry farm in British Columbia. Poster presented at the Annual General Meeting of the Entomological Society of Canada (Quebec City, PQ, October 1998) and the North American Cranberry Research and Extension Workers Conference (Long Beach, WA, September 1999).

University of British Columbia. 2011. Malcolm Knapp Research Forest. Web site: http://www.mkrf.forestry.ubc.ca/general/index.htm. [Accessed February 2011.]

Ward, P., Moore, K. and Kistritz, R. 1992. Wetlands of the Fraser Lowland, 1989: an inventory. Technical Report Series No. 146. Canadian Wildlife Service, Vancouver.

Ward, P., Radcliffe, G., Kirkby, J., Illingworth, J., and Cadrin, C. 1998. Sensitive ecosystems inventory: east Vancouver Island and Gulf Islands 1993-1997. Volume 1: methodology, ecological descriptions and results. Technical Report Series No. 320, Canadian Wildlife Service, Vancouver, BC.

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Allan Harris is a biologist with over 20 years' experience in northern Ontario. He has a B.Sc. in Wildlife Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After spending seven years as a biologist with Ontario Ministry of Natural Resources, he co-founded Northern Bioscience, an ecological consulting company based in Thunder Bay, Ontario. Al has authored or coauthored dozens of scientific papers, technical reports, and popular articles, including COSEWIC status reports for Gibson's Big Sand Tiger Beetle, Crooked-stem Aster, Bogbean Buckmoth, Laura's Clubtail, Rapids Clubtail, Northern Barrens Tiger Beetle, Drooping Trillium, and Small-flowered Lipocarpha. Al also authored the Ontario provincial status report for Woodland Caribou, and has authored or coauthored national and provincial recovery strategies for vascular plants and birds. He is a member of the Committee on the Status of Species at Risk in Ontario (COSSARO).

Robert Foster is co-founder and principal of Northern Bioscience, an ecological consulting firm offering professional consulting services supporting ecosystem management, planning, and research. Dr. Foster has a B.Sc. in Biology from Lakehead University and a D. Phil. in Zoology from the University of Oxford. Rob has worked as an ecologist in Ontario for over 15 years, and has authored or coauthored COSEWIC status reports on Gibson's Big Sand Tiger Beetle, Weidemeyer's Admiral, Bogbean Buckmoth, Laura's Clubtail, Rapids Clubtail, Northern Barrens Tiger Beetle, Crooked-stem Aster and Drooping Trillium, as well as recovery plans for rare plants, lichens, and odonates.

COLLECTIONS EXAMINED

The following institutions were searched for Canadian specimens of Georgia Basin Bog Spider:

Canadian National Collection – searched by Shashi Juneja, 2010. Also searched by Robb Bennett in preparation for Bennett *et al.* (2006)

Royal British Columbia Museum – searched by Robb Bennett in preparation for Bennett *et al.* (2006)

American Museum of Natural History – enquiry to N.I. Platnick from Robb Bennett in preparation for Bennett *et al.* (2006)

Burke Museum – enquiry to R.L. Crawford from Robb Bennett in preparation for Bennett *et al.* (2006)

Appendix 1. Calculation of Canadian Extent of Occurrence and Index of Area of Occupancy.

Extent of Occurrence

The total extent of occurrence of Georgia Basin Bog Spider in Canada, including sites with transient non-viable occurrences, is 1306 km^2 as measured by convex polygon (Figure 8, red line). Of this area, over half is ocean and about 25% is in the United States. Considering only viable current or historical populations, the extent of occurrence of Georgia Basin Bog Spider in Canada is 620 km^2 (Figure 8, green line). Of this area, about half is ocean (Canadian and United States).

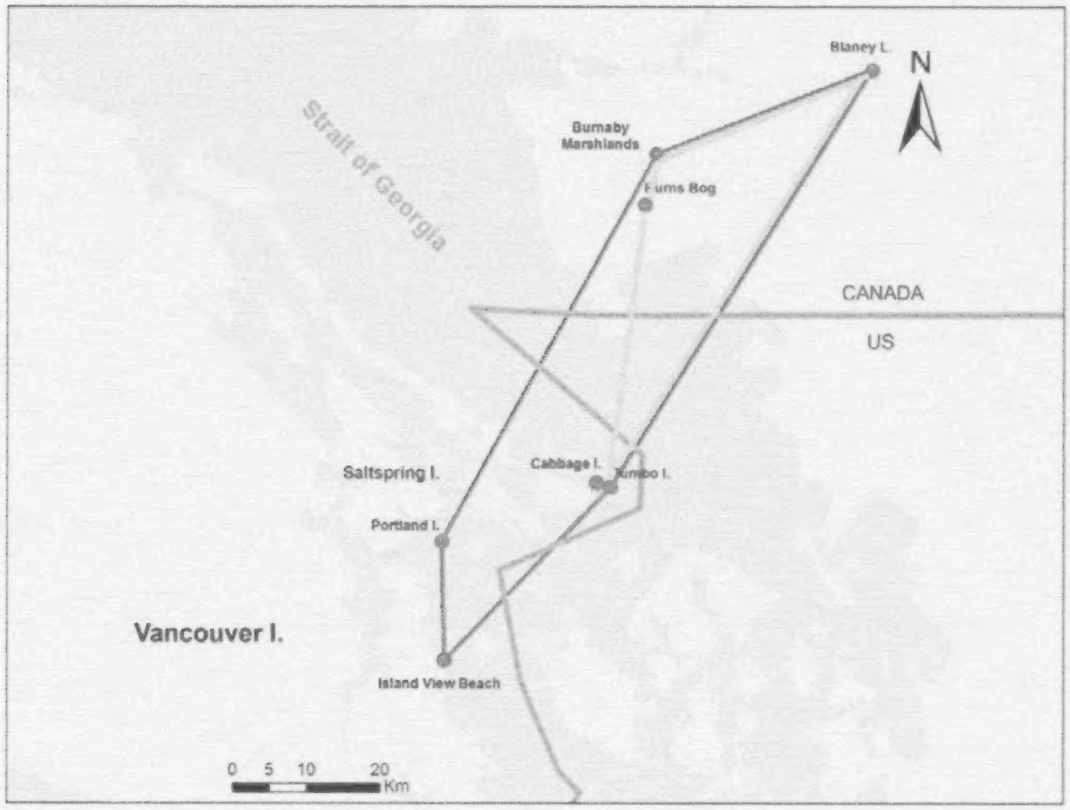

Figure 8. Maximum extent of occurrence map for Georgia Basin Bog Spider in Canada using convex polygon (red line: non-viable occurrences included; green line: non-viable occurrences excluded).

Index of Area of Occupancy

The index of area of occupancy of Georgia Basin Bog Spider in Canada is 20-28 km^2 (as measured with a 2 km X 2 km grid) (Figure 9) or 3-5 km^2 (as measured with a 1 km X 1 km grid) (Figure 10). The larger number in each range includes presumed transient, non-viable occurrences on Cabbage and Portland Islands and at Island View Beach; the smaller number in each range excludes those populations.

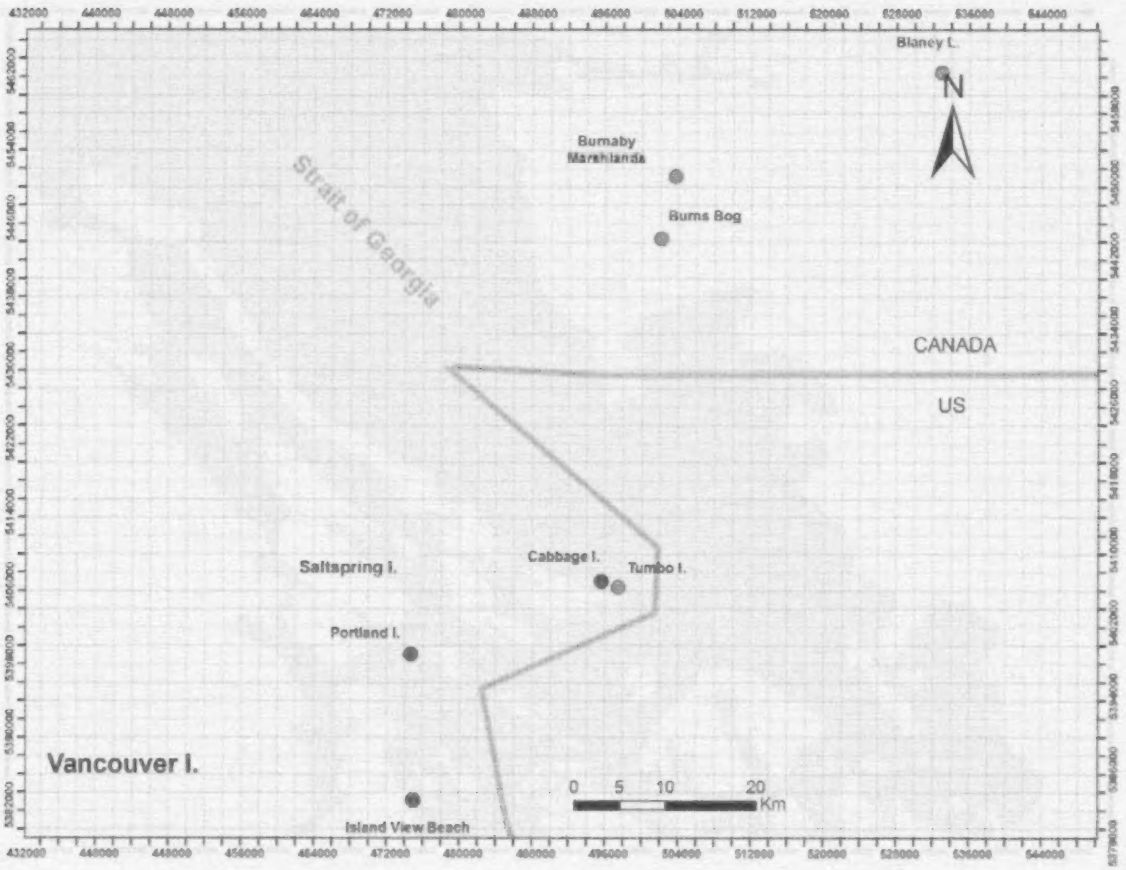

Figure 9. Index of area of occupancy for Georgia Basin Bog Spider in Canada using 2 km X 2 km grid. Red dots indicate viable populations, blue dots indicate non-viable occurrences.

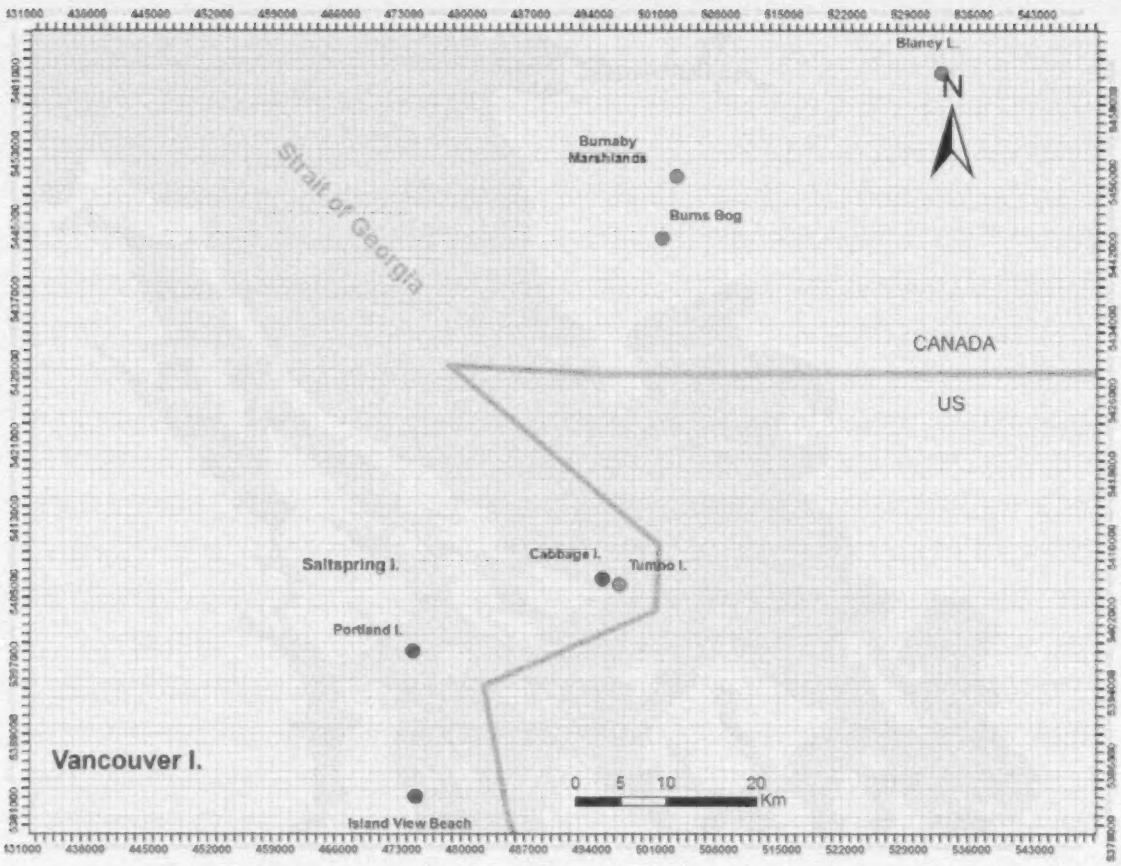

Figure 10. Index of area of occupancy for Georgia Basin Bog Spider in Canada using 1 km X 1 km grid. Red dots indicate viable populations, blue dots indicate non-viable occurrences.